

Appl. No. : 10/810,415  
Filed : March 25, 2004

### REMARKS

Claims 1-28, 33-47, 51-52 and 63-66 are pending in the present application, and stand rejected on a variety of grounds, each of which is addressed below. Claims 1 and 33 have been amended. Claims 48-50 have been canceled and rewritten into new Claims 64-66 to recite proper antecedent basis. No new matter has been added.

Although the Office Action Summary notes that Claims 29-32 have been canceled, Claims 29-32 were addressed in the Office Action as rejected under 35 U.S.C. § 103. Applicants respectfully request acknowledgement that 29-32 have been canceled.

#### Claim Rejections Under 35 U.S.C. § 102

Claims 1-4, 10-13, 15-19, 21-24, 27, 28, 33-37, 48, 49, 52 and 63 are rejected under 35 U.S.C. § 102 as being anticipated by Soininen et al. (U.S. Patent No. 6,482,740). This rejection is traversed.

#### Independent Claim 1

Applicants respectfully submit that Soininen et al. fails to teach or suggest all the limitations of independent Claim 1. However, to facilitate prosecution, Applicants have amended Claim 1 to recite that the metal oxide layer is formed by “oxidizing a top layer of the diffusion barrier to form a metal oxide layer, wherein the oxidizing forms the metal oxide layer from metal in the diffusion barrier.” Support for the amendment can be found, for example, in paragraph [0047] and FIGS. 5-6 of the Application.

Soininen et al. discloses a metal oxide thin film that is *deposited* on diffusion barrier 14 from alternating pulses of a metal source and an oxygen source by, for example, ALD. (Col. 7, lines 26-29, 50, 63-64; FIG. 1). Soininen et al. discloses that the metal oxide film *deposited* on diffusion barrier 14 is then reduced into a metal layer and used as a seed layer 16. (Col. 7, lines 35-37). However, there is no teaching or suggestion in Soininen et al. that the metal oxide film is formed by “oxidizing a top layer” of diffusion barrier 14, “wherein the oxidizing forms the metal oxide layer from metal in the diffusion barrier,” as recited in independent Claim 1.

Moreover, the Office Action states on page 2 that Soininen et al. discloses this limitation by teaching that a “metal oxide layer is created by the interaction of the nitrogen gas in ALD

**Appl. No.** : 10/810,415  
**Filed** : March 25, 2004

reaction chamber with the top surface of the diffusion barrier.” However, Applicants submit that mere “interaction” of the nitrogen gas with a top surface of a layer is not the same as *oxidation*, nor does interaction with “nitrogen” cause *oxidation* of a diffusion barrier. There is also no teaching or suggestion in the section of Soininen et al. cited in the Office Action (Col. 7, lines 5-67), or elsewhere, that the metal oxide film 16 is formed by “oxidizing a top layer” of diffusion barrier 14, as recited in Claim 1. The amendment to Claim 1 makes even more clear that a *deposited* metal oxide like that disclosed in Soininen et al. does not teach or suggest a metal oxide formed from metal in the diffusion barrier.

Thus, since Soininen et al. fails to teach or suggest “oxidizing a top layer of the diffusion barrier, wherein the oxidizing forms the metal oxide layer from metal in the diffusion barrier,” as recited in Claim 1, Applicants respectfully request withdrawal of the rejection under 35 U.S.C. § 102 of independent Claim 1 and Claims 2-4, 10-13, 15-19, 21-24 and 28 which depend therefrom.

#### Independent Claim 33

Applicants respectfully submit that Soininen et al. fails to teach or suggest all the limitations of independent Claim 33. However, to facilitate prosecution, Applicants have amended Claim 33 to clarify that the preparation process to form the nucleation layer comprises “exposing the diffusion barrier layer to an oxidant and a reducing agent,” and that depositing a conductor over the nucleation layer occurs “after the preparation process is complete.” Support for the amendments can be found, for example, in paragraphs [0052] to [0055] of the Application.

Soininen et al. discloses a trench structure with a diffusion barrier 14 (e.g., TaN), a seed layer 16 and a trench fill metal 18 (e.g., Cu). (FIG. 1, Col. 5, lines 45-52). In particular, Soininen et al. discloses that a metal oxide is deposited on diffusion barrier 14 by, e.g., ALD, and subsequently reduced. (Col. 7, lines 26-29, 35-37, 50, 63-64; FIG. 1). There is no teaching or suggestion in Soininen et al. of forming a nucleation layer by “exposing the diffusion barrier layer to an oxidant and a reducing agent,” as recited in amended Claim 33.

Moreover, the Office Action alleges on pages 2-3 that Soininen et al. teaches “depositing a conductor (i.e. a second Cu seed layer as seen in Col. 2 lines 7-15) directly on the first seed

Appl. No. : 10/810,415  
Filed : March 25, 2004

layer 16 (i.e. metal layer) that is different in composition from the nucleation layer (i.e. oxide layer).” From the above statement, it appears that “the first seed layer 16 (i.e. metal layer)” is referred to as the nucleation layer, but “the oxide layer” 16 is then parenthetically referred to as the nucleation layer. By reference to the *metal* layer 16 as the recited “nucleation layer” over which the conductor is deposited, and then to the *oxide* layer 16 as the “nucleation layer” that is different from the allegedly overlying seed layer, the *reduced metal* layer 16 in Soininen et al. is equated to its *unreduced oxide* state.

Applicants submit that amended Claim 33 precludes reference to the *reduced metal* layer 16 of Soininen et al. as the “nucleation layer” for a first portion of the recited limitation, and then alternatively to the *unreduced oxide* state of layer 16 as the “nucleation layer” for the second portion of the recited limitation. Applicants accordingly submit that there is no teaching or suggestion in Soininen et al. of depositing a conductor over the nucleation layer to form a seed layer that is different from the nucleation layer, after the preparation process to form the nucleation layer is completed.

Thus, since Soininen et al. fails to teach or suggest “performing a preparation process on the substrate to form a nucleation layer, the preparation process comprising exposing the diffusion barrier layer to an oxidant and a reducing agent” and “depositing a conductor over the nucleation layer to form a seed layer that is different from the nucleation layer after the preparation process is complete,” as recited in amended independent Claim 33, Applicants respectfully request withdrawal of the rejection under 35 U.S.C. § 102 of independent Claim 33 and Claims 34-37, 48, 49, 52 and 63 which depend therefrom.

#### **Claim Rejections Under 35 U.S.C. § 103**

Claims 5-9, 14, 25-26, 29-32, 44-47 and 50 are rejected under 35 U.S.C. § 103 as being unpatentable over Soininen et al. as applied to Claims 1 and 33, and further in view of Elers et al. (WO 01/29893). This rejection is traversed.

As discussed above, Soininen et al. fails to teach or suggest “oxidizing a top layer of the diffusion barrier to form a metal oxide layer, wherein the oxidizing forms the metal oxide layer from metal in the diffusion barrier,” as recited in independent Claim 1. Soininen et al. also fails to teach or suggest “performing a preparation process on the substrate to form a nucleation layer,

**Appl. No.** : 10/810,415  
**Filed** : March 25, 2004

the preparation process comprising exposing the diffusion barrier layer to an oxidant and a reducing agent” and “depositing a conductor over the nucleation layer to form a seed layer that is different from the nucleation layer after the preparation process is complete,” as recited in independent Claim 33. Claims 5-9, 14, 25-26, 29-32, depend from Claim 1, and Claims 44-47 and 50 depend from Claim 33, and contain all the limitations thereof in addition to further distinguishing features. Applicants submit that Elers et al. fails to cure the deficiencies of Soininen et al. There is no teaching or suggestion in Elers et al. of the above recited limitations. Therefore, Applicants request withdrawal of the rejection to Claims 5-9, 14, 25-26, 29-32, 44-47 and 50.

Claims 20 and 51 are rejected under 35 U.S.C. § 103 as being unpatentable over Soininen et al. as applied to Claim 1, and further in view of Chen et al. (U.S. Patent No. 6,753,249). This rejection is traversed.

Claims 20 and 51 depend from independent Claims 1 and 33, respectively, and contain all the limitations thereof in addition to further distinguishing features. Applicants submit that Chen et al. fails to cure the deficiencies of Soininen et al. There is no teaching or suggestion in Chen et al. of “oxidizing a top layer of the diffusion barrier to form a metal oxide layer, wherein the oxidizing forms the metal oxide layer from metal in the diffusion barrier,” as recited in independent Claim 1. Chen et al. also fails to teach or suggest “performing a preparation process on the substrate to form a nucleation layer, the preparation process comprising exposing the diffusion barrier layer to an oxidant and a reducing agent” and “depositing a conductor over the nucleation layer to form a seed layer that is different from the nucleation layer after the preparation process is complete,” as recited in independent Claim 33. Therefore, Applicants request withdrawal of the rejection to Claims 20 and 51.

Claims 38-43 are rejected under 35 U.S.C. § 103 as being unpatentable over Soininen et al. as applied to Claims 33 and 36, and further in view of Aaltonen et al. (U.S. 2003/0165615). This rejection is traversed.

Claims 38-43 depend from Claim 33 and contain all the limitations thereof in addition to further distinguishing features. Applicants submit that Aaltonen et al. fails to cure the deficiencies of Soininen et al. There is no teaching or suggestion in Aaltonen et al. of “oxidizing a top layer of the diffusion barrier to form a metal oxide layer, wherein the oxidizing forms the

**Appl. No.** : **10/810,415**  
**Filed** : **March 25, 2004**

metal oxide layer from metal in the diffusion barrier,” as recited in independent Claim 1.

Aaltonen et al. also fails to teach or suggest “performing a preparation process on the substrate to form a nucleation layer, the preparation process comprising exposing the diffusion barrier layer to an oxidant and a reducing agent” and “depositing a conductor over the nucleation layer to form a seed layer that is different from the nucleation layer after the preparation process is complete,” as recited in independent Claim 33. Therefore, Applicants request withdrawal of the rejection to Claims 38-43.

**Appl. No.** : 10/810,415  
**Filed** : March 25, 2004

**CONCLUSION**

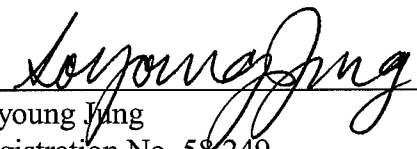
In view of the arguments presented above, Applicants submit that the present application is in condition for allowance and respectfully requests the same. If any issues remain, the Examiner is cordially invited to contact Applicant's representative provided at the number provided below in order to resolve such issues promptly.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: 6/29/07

By:   
Soyoung Jung  
Registration No. 58,249  
Attorney of Record  
Customer No. 20,995  
(415) 954-4114

3809815  
052507